

1889, I found a nest in a small oak, containing two eggs. May 4, 1894, I found a pair brooding. May 16, a pair were building in an oak, fifteen to twenty feet above the ground. May 28, the birds seemed to be through building and were flitting about warbling and apparently taking a rest before time to begin brooding. May 31, after a Blue Jay had created an excitement in the oak, the Gnatcatchers began taking their nest to pieces, and went to work putting it up in a low oak a few rods away. June 7 the birds were still building. June 11 they were brooding, changing places in the nest. June 25 the young were being fed. July 4 the young were out, being fed in the brush. From May 16, or more accurately May 14—for the nest had been begun at least two days before I found it—from May 14 to July 4, those birds were working to get one brood launched. The first nest took them two weeks, the second one about ten days. Their method of work was interesting. The nest was laid on a horizontal branch. Their plan seemed to be twofold, to make the walls compact and strong by using only fine bits of material and packing them tightly together—drilling them in—and at the same time to give the walls form and keep them trim and shipshape by moulding inside and smoothing the rim and the outside. Sometimes the builder would smooth the brim with its neck and bill like a Redstart, as a person sharpens a knife on a whetstone, a stroke one way and then a stroke the other. The birds usually got inside to work, but there was a twig beside the nest that served for scaffolding, and they sometimes stood on that to work on the outside. They both worked, flying rapidly back and forth with material. The second nest rested lightly on a horizontal limb, but was supported mainly by two twigs which forked so as to enclose it. It was a beautiful nest, covered with lichen and lined with feathers. The birds were not at all shy. They let me come so near that I saw the black lines bordering the blue forehead of the male.

*Sialia mexicana occidentalis.* WESTERN BLUEBIRD.—Mr. Merriam told me he had seen the Bluebirds build in the mud nests of Swallows in trees; but most frequently in knot holes and in the abandoned nests of the small Woodpeckers.

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## THE LAW WHICH UNDERLIES PROTECTIVE COLORATION.

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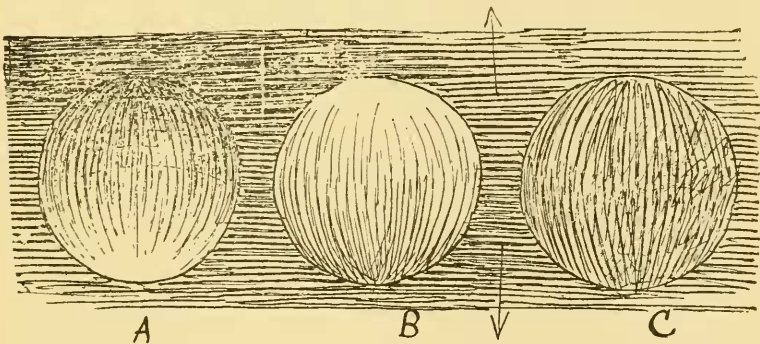
THIS article is intended to set forth a beautiful law of nature which, so far as I can discover, has never been pointed out in print. It is the law of gradation in the coloring of animals, and

is responsible for most of the phenomena of protective coloration except those properly called mimicry.

Naturalists have long recognized the fact that the coloring of many animals makes them difficult to distinguish, and have called the whole phenomenon protective coloration, little guessing how wonderful a fact lay hidden under the name.

*Mimicry makes an animal appear to be some other thing, whereas this newly discovered law makes him cease to appear to exist at all.* The following are some examples of true mimicry. The Screech Owl, when startled, makes himself tall and slim, and with eyes shut to a narrow line simulates a dead stub of the tree on which he sits. Certain Herons stretch their necks straight upward, and with head and green beak pointed at the zenith, pass themselves off for blades of sedge grass. Certain harmless snakes spread their heads out flat, in imitation of their poisonous cousins, and rattle with their tails in the leaves. Many butterflies have stone or bark-colored under sides to their wings, which make them look like a bit of bark or lichen when they sit still on a stone or tree trunk with wings shut over their backs.

The newly discovered law may be stated thus: Animals are painted by nature, darkest on those parts which tend to be most lighted by the sky's light, and *vice versa*.



The accompanying diagram illustrates this statement. Animals are colored by nature as in A, the sky lights them as in B, and the two effects cancel each other, as in C. The result is that their gradation of light and shade, by which opaque solid

objects manifest themselves to the eye, is effaced *at every point*, the cancellation being as complete at one point as another, as in Fig. C of the diagram, and the spectator seems to see right through the space really occupied by an opaque animal.

Fig. 1 of a Ruffed Grouse shows this arrangement of color and light. This bird belongs to the class in which the arrangement is found in its simplest form, the color making a complete gradation from brown above to silvery white beneath, and conforming to every slightest modelling; for instance, it grows light under the shelving eyebrow, and darker again on the projecting cheek.

When he stands alive on the ground, as in Fig. 2, his obliteration by the effect of the top light is obvious.

Writers say "he is so nearly like the color of his surroundings that you cannot see him." Fig. 3 is to show that they ascribe the concealment to the wrong cause. I merely took the bird shown in Fig. 2, and accurately tinted his under parts with brown to match his back, and in less degree tinted his sides, till I had reduced him to uniformity of color all over; but I did not, of course, change his upper surfaces at all. In short, I extended his 'protective' colors all over him.

Now observe the effect on replacing him in a life-like position. He is completely unmasked. The reader has but to compare the distance at which he can distinguish a bird in No. 2 and in No. 3 respectively, to see whether simple 'protective coloration,' as ordinarily defined, is the true cause of this concealment, or whether this compound gradation of color and light is the true cause.

Fig. 4 and Fig. 5 show that his colors are powerless to conceal him in any position except the upright one which he holds when alive, and Figs. 6 and 7 do the same for the Woodcock.

In Figs. 5 and 6, notwithstanding the fact that we have even the strongest 'protective' colors towards us, the bird is by no means concealed.

The Woodcock series corresponds to that of the Ruffed Grouse. Fig. 8 shows a female on her nest, very difficult to find. In Fig. 9 the bird has been treated exactly as I treated the Ruffed Grouse in Fig. 3. Observe that she is essentially more conspicuous, though not a feather of her upper parts has been artificially painted.



FIG. 1. SIDE VIEW OF DEAD GROUSE TO SHOW COLOR GRADATION.



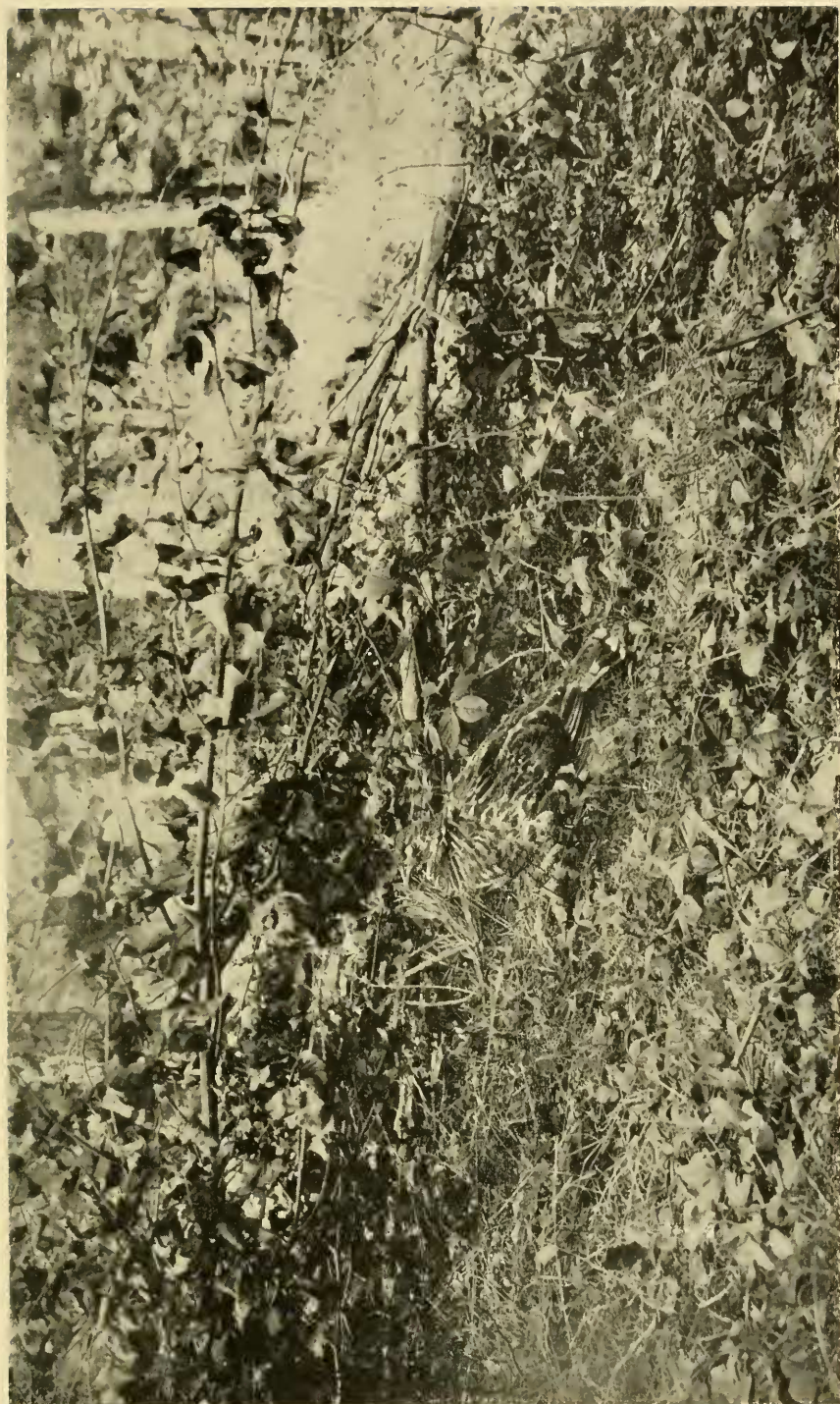


FIG. 2. GROUSE POSED ON THE GROUND AS IN LIFE.